ST. LOUIS UNIVERSITY
CORE ELECTROCARDIOGRAPHIC LABORATORY
HEALTH ABC PROJECT

CORE ECG LAB METHODOLOGY REPORT

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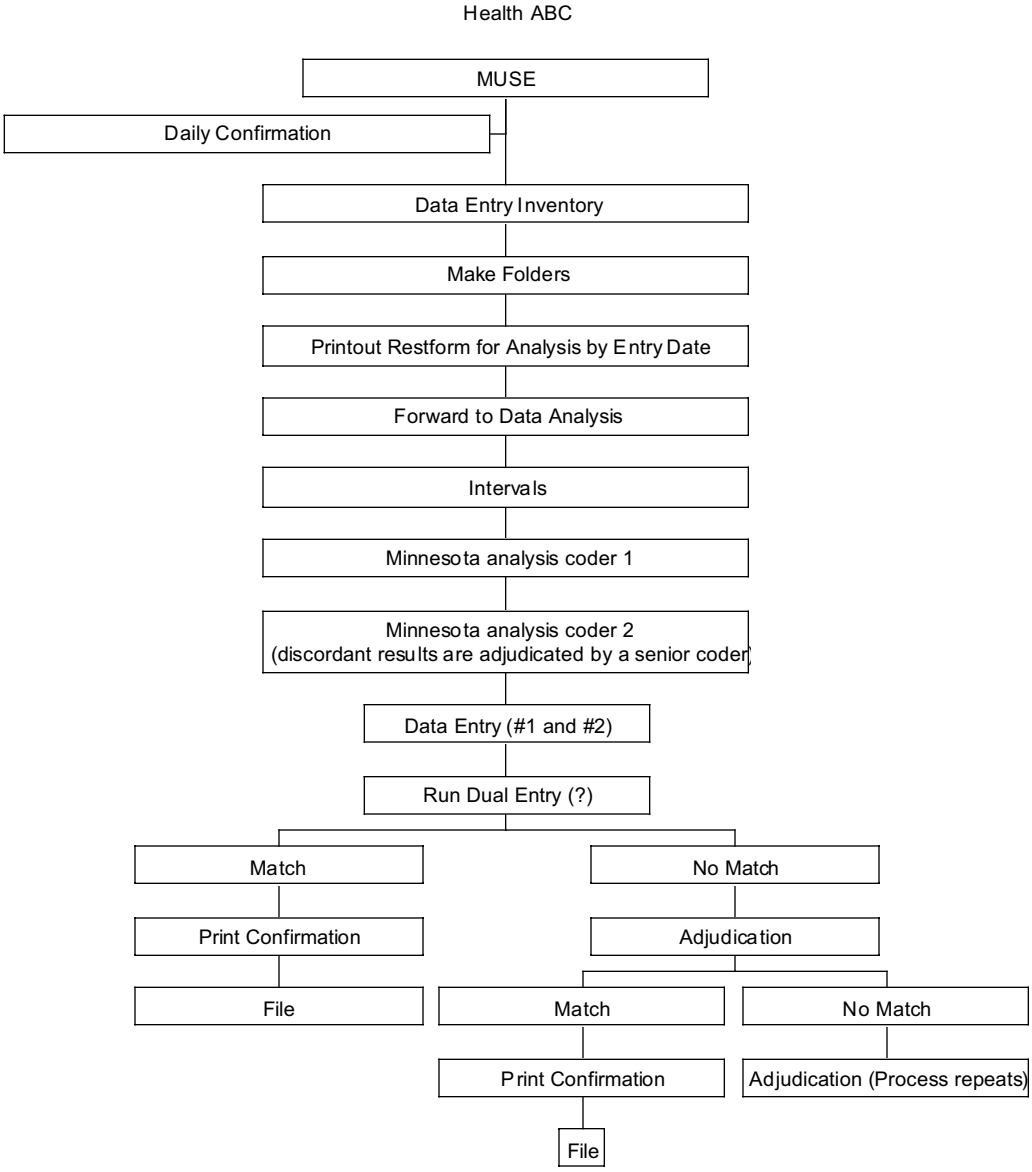
The Core ECG lab maintains detailed standard operating procedures(SOP). Sections of the standard operating procedures have been excerpted for this report. A complete list of SOP documents are included here as a reference.

CURRENT NUMBERED CORE ECG LAB SOPS AND PHYSICAL LOCATION OF THE DOCUMENTATION

SOP #	SOP title	Created date	Modification date	Hard copy file location	Electronic file location
1	Standard Operating Procedure Master Document	3/10/97	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #1
2	Core ECG Lab Manual of Operations	7/93	1/94 2/97	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #2
3	Core ECG Lab Training Manual	2/97	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #3
4	Core ECG Laboratory Protocol criteria for Infarction and Ischemia	1/96	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	NA
5	Database Design, Management and backup Procedures	2/97	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	NA
6	Computer Program Validation				
	Part 1 Exercise ECG Analysis	3/97	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #6
	Part 2 Minnesota Code Analysis		NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #6
	Part 3 Serial Comparison Analysis	2/97	NA	SOP lateral file cabinet at the CEL 1034 S. Brentwood Suite 1550	O:Stocke:SOP and Validation: SOP #6

ELECTROCARDIOGRAPHIC DATA MANAGEMENT FOR HEALTH ABC

Electrocaridiographic data are acquired at the clinical unit using standardized techniques as documented in the ABC Core ECG Lab Manual of Operations. ECG data are transmitted over the phone line from the Marquette ECG recording cart at the clinical site to A Marquette Muse at the Core ECG lab. ECGs are electronically stamped with the study name, patient-identifying information, test visit, ECG date and time and technician number. As ECGs are received at the Core ECG Lab, they are electronically stored in a cumulative ABC ECG file and are individually printed out on standard ECG recording paper. In a small number of ECGs, the electronic data are not available and the ECG is received by mail. The Core ECG lab electronically tracks quality parameters and provides the site with confirmation reports that includes quality parameters. The flow of ECG data from receipt to filing is illustrated below:



ECG MEASUREMENT TECHNIQUES AND QUALITY CONTROL

The following training information is excerpted form: Core Electrocardiographic Laboratory Training Manual Standard Operating Procedure Document #3

TECHNICAL TRAINING

Each employee involved with analysis at the Core ECG Lab will be trained in the areas that are required to fulfill his/her job responsibilities. Training is staged in levels for each area of analysis. The employee will complete the levels progressing from stage 1 to the last stage. At the completion of training in the last stage, the employees will be authorized in that area. Training documentation is included for each stage and each section, at the completion of training for each stage and section, the person supervising the training will sign and date the document indicating the trainee is competent in that area of analysis. All analysis data is reviewed by a minimum of two authorized coders.

The 4 types of analysis are:

- Resting 12 lead ECG analysis
- Serial ECG analysis
- Myocardial event analysis
- Exercise ECG analysis

New employees will be trained using reference material and patient file examples of code. An error rate of < 5% will determine if an employee meets acceptable criteria for authorization in any particular analysis area.

RESTING 12 LEAD ECG DATA ANALYSIS

The 12 lead Resting ECG

Overview of 12 lead ECG

An overview to the generation and significance of the 12 lead ECG will be provided.

Reference books for 12 lead ECG overview:

The Minnesota Code Manual of Electrocardiographic Findings, Ronald J. Prineas, Richard S. Crow, Henry Blackburn, John Wright, Littleton, MA; 1982.

Generation and Interpretation of the Electrocardiogram, Robert Paine; Lea & Febiger,Philadelphia, PA; 1988.

Electrocardiography in Clinical Practice, Te-Chuan Chou, Grune& Stratton , New York, NY, 1979

Rest ECG Level 1 analysis

Familiarity with coding forms

Review the coding forms and correct completion of coding forms based on the CEL manual of operations SOP #2.Minnesota

Interval Measurements

Details on measuring the following intervals are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings

Heart rate: pg. 169

Axis: pg. 172

QT: pg. 181

QRS: pg. 111

PR: pg. 99

Rest ECG Level 2 analysis

T wave and ST depression Codes

Details on measuring T waves and ST depression codes are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 60-98

ST Elevation Codes

Details on ST elevation codes are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 160-164

Rest ECG Level 3 analysis

Q wave Codes

Details on Q wave codes are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 16-48

Rest ECG Level 4 analysis: Complete Minnesota Code Analysis

Completion of this level of Rest ECG coding will result in authorization of the employee to provide complete Minnesota code analysis as one of the 2 authorized coders. Prior to this authorization, the trainee analysis is under continual review from the trainer,; after authorization the trainee may provide complete Minnesota code as one of the two coders to review resting 12 lead ECGs.

LVH

LVH coding details are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 55-60

Arrhythmias

Arrhythmia coding details are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 131-157

Ventricular Conduction Defects

Ventricular conduction defect coding details are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 111-131

Atrial Conduction Defects

Atrial conduction defect coding details are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 98-111

Suppression Codes

Suppression code details are documented in the reference The Minnesota Code Manual of Electrocardiographic Findings. page 229

SERIAL COMPARISON

A minimum requirement for training: Analysis authorization in Minnesota Code analysis.

Level 1 Serial Comparison

Coding Rules

Coding rules are documented in the CEL Manual of Operations (SOP #2). Trainees will be taught the coding rules with examples of the various override rules from patient study files.

Level 2 Serial Comparison

Application of coding rules

Trainees will apply the coding rules, and the analysis will be reviewed by the trainer. When the trainee can apply the serial coding rules with less than 5% disagreement from the trainer, the trainer will authorize the trainee in Serial Comparison Analysis.

ECG MEASUREMENT TECHNIQUES

ECGs are analyzed by trained coders using a 7 power coding loupe. Each ECG is reviewed by 2 coders. A senior coder adjudicates discordant results. The Minnesota code is generated using a validated (CEL SOP#6) computer software program. The Minnesota codes and the corresponding measurements that generate the codes are detailed below.

MINNESOTA CODE ANALYSIS CORRESPONDING DEFINITIONS

Minnesota and Supplemental Codes

Q and QS Patterns

(Do not code in the presence of WPW code 6-4-1.) To qualify as a Q-wave, the deflection should be at least 1.0 mv

Anterolateral site (leads I, aVL, V6)

1-1-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 sec in lead I or V6.
1-1-2 Q duration ≥ 0.04 sec in lead I or V6.
1-1-3 Q duration ≥ 0.04 sec, plus R amplitude≥3 mm in lead aVL.
1-2-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 sec and 0.03 sec in lead I or V6.
1-2-2 Q duration ≥ 0.03 sec. and < 0.04 sec in lead I or \V6.
1-2-3 QS pattern in lead I. Do not code in he presence of 7-1-1).
1-2-8 Initial R amplitude decreasing to 2 mm or less in every beat (and abscence of codes 3-2, 7-1-1, 7-2-1or 7-3 between V5 and V6 (all beats in V5 must have an initial R amplitude > 2mm.)
1-3-1 Q/R amplitude ratio > _ 1/5 and < 1/3, plus Q duration≥ 0.02 sec and < 0.03 src in I or V6.
1-3-3 Q duration > _ 0.03 ans < 0.04 sec, plus R amplitude ≥ 3 min in a VL.
1-6-2 Q/R amplitude ratio < 1/5, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead I or V6.
1-6-3 Q duration > _ 0.02 and < 0.03 sec, plus R amplitude >_ 3 mm in lead aVL.
1-7-2 Q/R amplitude ratio > _ 1/3, plus Q duration > _ 0.015 sec and < 0.02 sec in lead I or V6.
1-7-3 Q duration > _ 0.015 and < 0.02 sec, plus R amplitude > _ 3 mm in a VL
1-8-1 Q/R amplitude ratio > _ 1/4 and < 1/3, plus Q duration > _ 0.015 sec and < 0.02 sec in I or V6.

Posterior (interior) site (leads II, III, a VF)

1-1-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 sec in lead II.
1-1-2 Q duration ≥ 0.04 sec in lead II.
1-1-4 Q duration ≥ 0.05 sec in lead III, plus Q wave amplitude ≥ 1mm in the majority of beats in aVF
1-1-5 Q duration ≥ 0.05 sec in aVF.
1-2-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 sec and< 0.03 in lead II.
1-2-2 Q duration ≥ 0.03 sec. and < 0.04 sec in lead II
1-2-3 QS pattern in lead II, Do not code in presence of 7-1-1)
1-2-4 Q duration ≥ 0.04 sec and < 0.05 sec in lead III, plus Q-wave ≥ 1.0 mm amplitude in the majority of beats in aVF.
1-2-5 Q duration ≥ 0.04 sec and < 0.05 sec in lead aVF.
1-2-6 Q amplitude ≥ 5.0 mm in leads III or aVF.
1-3-1 Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead II.
1-3-4 Q duration ≥ 0.03 sec and < 0.04 sec in lead III, plus a Q wave ≥ 1.0 mm amplitude in the majority of beats in aVF.
1-3-5 Q duration ≥ 0.03 sec and < 0.04 sec in lead aVF.
1-3-6 QS pattern in each of leads III and aVF. (Do not code in presence of 7-1- 1.)
1-6-4 Q duration ≥ 20 m and < 30 m sec in lead III, plus Q wave amplitude ≥ 1.0 mm in the majority of beats in lead aVF.
1-6-5 QS duration ≥ 20 m sec in lead aVF.
1-6-6 QS pattern in lead III, plus Q wave amplitude ≥ 1.0 in the majority of beats in lead aVF.
1-7-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 15 m sec and < 20 m sec in lead II.
1-8-1 Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 15 m sec and <20 sec in lead II.

Anterior site (leads V1, V2, V3, V4, V5)

1-1-1 Q/R amplitude ratio ≥ 1/3/, plus Q duration ≥ 0.03 sec in any of leads V2, V3, V4, V5.
1-1-2 Q duration ≥ 0.04 sec in any of leads V1,V2,V3,V4,V5.
1-1-6 QS pattern when initial R-wave is presented in adjacent lead to the right on the chest, in any of leads V2,V3,V4,V5,V6.
1-1-7 QS pattern in all of leads V1 - V4, or V1 - V5.
1-2-1 Q/R amplitude ratio ≥ 1/3 plus Q duration ≥ 0.02 sec and 0.03 sec,in any of leads V2,V3,V4,V5.
1-2-2 Q duration ≥ 0.03 and < 0.04 sec in any of leads V2,V3,V4,V5.
1-2-7 QS pattern in all of leads V1,V2, and V3. (Do not code in the presence of 7-1-1.)
1-2-8 Initial R amplitude decreasing to 2 mm or less in every beat (and absence of codes 3-2, 7-1-1;7-2-1, or 7-3) between any of the leadsV2 and V3, V3 and V4, or V4 and V5. (All beats in the lead immediately to the right of the chest must have an initial R> 2 mm.)
1-3-1 Q/R amplitude ratio ≥ 1/5 and < 1/3 plus Q duration ≥ and < 0.03sec and < 0.03 sec in any of leads V2, V3, V4, V5.
1-3-2 QS pattern in lead V1 and V2. (Do not code in the presence of 3-1 or 7-1-1.)
1-4-1 R wave V1 -4 ≤ 1.5 mm and ST ≥ 2 mm with T wave inversion in at least 2 leads.
1-4-2 R wave V1 -4 ≤ 2 mm and ST ≥ 2 mm with T wave inversion in at least 2 leads.
1-4-3 R wave V1 -4 ≤ 1.5 mm and ST ≥ 1 mm with T wave inversion in at least 2 leads.
1-4-4 R wave V1 -4 ≤ 2 mm and ST ≥ 1 mm with T wave inversion in at least 2 leads.
1-4-5 R wave V1 -4 ≤ 1.5 mm and T wave inversion in at least 2 leads.
1-4-6 R wave V1 -4 ≤ 2 mm and T wave in at least 2 leads.
1-5-1 R wave V1 -3 ≤ 1.5 mm and ST ≥ 2 mm with T wave inversion in at least 2 leads.
1-5-2 R wave V1 -3 ≤ 2 mm and ST ≥ 2 mm with T wave inversion in at least 2 leads.
1-5-3 R wave V1 -3 ≤ 1.5 mm and ST ≥ 1 mm with T wave inversion in at least 2 leads.
1-5-4 R wave V1 -3 ≤ 2 mm and ST ≥ 1 mm with T wave inversion in at least 2 leads.
1-5-5 R wave V1 -3 ≤ 1.5 mm and T wave inversion in at least 2 leads.
1-5-6 R wave V1 -3 ≤ 2 mm and T wave inversion in at least 2 leads.

1-6-2 Q duration ≥ 20 msec and < 30 msec in any leads of V2, V3,V4,V5.
1-6-8 Initial R amplitude ≤ .5 mm in all leads V1,V2,V3 and V4.

High Amplitude R Waves

3-1 Left: R amplitude > 26 mm in either V5 or V6, or R amplitude > 20.0 mm in any of leads I,II, or III, aVF, or R amplitude > 12.0 mm in lead aVL measured only on second to last complete normal beat.
3-2 Right: R amplitude ≥ 5.0 mm and R amplitude ≥ S amplitude in the majority of beats in lead V1, when S amplitude is > R amplitude somewhere to the left on the chest of V1 (codes 7-3 and 3-2, if criteria for both are present.
3-3 Left (optional code when 3-1 is not present): R amplitude > 15.0 mm but ≤ 20.0 mm in lead I, or R amplitude in V5 or V6, plus S amplitude in V1 > 35.0 mm.
3-4 Criteria for 3-1 and 3-2 both present.

ST Junction (J) and Segment Depression

(Do not code in the presence of codes 6-4-1, 7-1-1, 7-2-1, or 7-4. When 4-1,4-2, or 4-3 is coded, then a 5-code must also be assigned except in lead V1.)

Anterolateral site (leads I, aVL, V6)

4-1-1 STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V6.
4-1-2 STJ depression ≥ 1.0 mm and < 2.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V6.
4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in any of leads II or aVF.
4-3 No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ mm and below P-R baseline, in any of leads I, aVL, or V6.
4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped, in any of leads I, aVL, or V6.

Posterior (inferior) site (leads II, III, aVF)

4-1-1 STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF.
4-1-2 STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF.
4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in lead II or aVF.
4-3 No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline in lead II.
4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping, or U-shaped, in lead II.

Anterior site (leads V1,V2,V3,V4,V5)

4-1-1 STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in any of leads V1,V2,V3,V4,V5.
4-1-2 STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in any of leads V1,V2,V3,V4,V5.
4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in any of leads V1,V2,V3,V4,V5.
4-3 No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baselinein any of leads V2,V3,V4,V5.
4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped in any of leads V1,V2,V3,V4,V5.
4-1-3 STJ depression ≥ 3.0 mm and ST segment horizontal downward sloping.
4-1-4 STJ depression ≥ 4.0 mm and ST segment horizontal or downward sloping.
4-1-X STJ depression ≥ X.0 mm and ST segment horizontal or downward sloping.

T-Wave Items

(Do not code in the presence of codes 6-4-1,7-1-1,7-2-1, or 7-4.)

Anterolateral site (leads I, aVL, V6)

5-1 T amplitude negative 5.0 mm or more in either of leads I, V6, or in lead aVL when R amplitude is ≥ 5.0 mm.
5-2 T amplitude negative or diphasic (positive-negative or negative-positive type) with negative phase at least 1.0 mm but not as deep as 5.0 mm in leads I or V6, or in leads aVL when R amplitude is ≥ 5.0 mm.
5-3 T amplitude zero (flat) or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase in lead I or V6, or in aVL when R amplitude is > 5.0 mm.
5-4 T amplitude positive and T/R amplitude ratio < 1/20 in any of leads I, aVL,V6; R wave amplitude must be ≥ 10.0 m.

Posterior (inferior) site (leads II,III, aVF)

5-1 T amplitude negative 5.0 mm or more in leads II, or in lead aVF when QRS is mainly upright.
5-2 T amplitude negative or diphasic (negative-positive or positive-negative type) at least 1.0 mm but not as deep as 5.0 mm in lead II, or in lead aVF when QRS is mainly upright.
5-3 T amplitude zero (flat) or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase in lead II; not coded in lead aVF.
5-4 T amplitude positive and T/R amplitude ratio < 1/20 in lead II; R wave amplitude must be ≥ 10.0 mm.

Anterior site (leads V2,V3,V4,V5)

5-6 T wave amplitude negative 5 mm or more in at least 3 leads V2,V3,V4 and V5.
5-1 T amplitude negative 5.0 mm or more in any of leads V2,V3,V4 V5.
5-5 T amplitude negative (flat), diphasic (negative-positive or positive-negative type) with negative phase at least 1.0 mm in at least 3 leads V2, V3, V4 V5.
5-2 T amplitude negative (flat), or diphasic (negative-positive or positive negative type) with negative phase at least 1.0 mm but not as deep as 5.0 mm in any leads V2,V3,V4,V5.
5-3 T amplitude zero (flat) or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase, in any of leads V3,V4,V5.
5-4 T amplitude positive and T/R amplitude ratio < 1/20 in any of leads V3, V4, V5; R wave amplitude must be ≥ 10.0 mm.

A-V Conduction Defect

6-1 Complete (third degree) A-V block (permanent or intermittent) in any lead. Atrial and ventricular complexes independent, and atrial rate faster than ventricular rate, with ventricular rate < 60.
6-2-1 Mobitz Type II (occurrence of P-wave on time with dropped QRS and T).
6-2-2 Partial (second degree) A-V block in any lead (2:1 or 3:1 block).
6-2-3 Wenckebach's Phenomenon (P-R interval increasing from beat to beat until QRS and T dropped.)
6-3 P-R (P-Q) interval ≥ 0.22 sec in the majority of beats in any of leads I, II,III,aVL, aVF.
6-4-1 Wolff-Parkinson-White Pattern (WPW), persistent. Sinus P-Wave, P-R interval < 0.12 sec plus QRS duration ≥ 0.12 sec, plus R peak duration ≥ 0.06 sec, coexisting in the same beat and present in the majority of beats in any of leads I ,II, aVL,V4,V5,V6. (6-4-1 suppresses 1-2-3, 1-2-7, 1-2-8, 1-3-2, 1-3-6, all 3,4,5, 9-2, 9-5 codes.)
6-4-2 WPW Pattern, Intermittent. WPW pattern in ≤ 50 % of beats in appropriate leads.
6-5 Short P-R Interval, P-R Interval < 0.12 sec in all beats of any two leads I,II,III,aVL,aVF.
6-6 Intermittent aberrant atrioventricular conduction. P-R > 0.12 sec (except in presence of 6.5 or heart beat greater than 100); wide QRS complex > 0.12 sec; normal P-wave when most beats are sinus rhythm. (Do not code in presence of 6-4-2.)
6-8 Artificial pacemaker.

Ventricular Conduction Defect

7-1-1 Complete left bundle branch block (LBBB). (Do not code in presence of 6-1,6-4-1.6-8,8-2-1 or 8-2-2.) QRS duration ≥ 0.12 sec in a majority of beats (of the same QRS pattern) in any of leads I,II,III,aVL,aVF, plus R peak duration ≥ 0.06 sec in a majority of beats (of the same QRS pattern) in any of leads I,II,aVL,V5,V6. (7-1-1 suppresses 1-2-3,1-2-7,1-2-8,1-3 2.1-3-6, all 2,3,4,5,9-2,9-4,9-5codes. If any other codable Q-wavecoexists with the LBBB pattern, code that Q and diminish the 7-1 code to a 7-4 code.

7-1-2 Intermittent left bundle branch block. Same as 7-1-1 but with presence of normally conducted QRS complexes or different shape than the LBBB pattern.

7-2-1 Complete right bundle branch block (RBBB). (Do not code in the presence of 6-1,6-4-1,6-8,8-2-1,or 8-2-2). QRS duration ≥ 0.12 sec in a majority of beats (of the same QRS pattern) in any of leads I, II, III, aVL,aVF, plus R > R in V1 or QRS mainly upright, plus R peak duration ≥0.06 sec in V1 or V2; or V2;or S duration > R duration in all beats in lead I or II. (Supresses 1-2-8,all 2-,3-,4- and 5- codes, 9-2,9-4,9-5.)

7-2-2 Intermittent right bundle branch block. Same as 7-2-1 but with the presence of norammly conducted QRS complexes of different shape than the RBBB pattern.

7-3 Incomplete right bundle branch block. QRS duration < 0.12 sec in each of leads I,II,III,aVL, and R' > R in either of leads V1,V2 (Code as 3-2 in addition if those criteria are met. 7-3 supresses code 1-2-8).

7-4 Intraventricular block. QRS duration ≥ 0.12 sec in a majority of beats in any of leads I,II,III,aVL,aVF. (7-4 supresses all 2,3,4,5,9-2, 9-4,9-5 codes.)

7-5 R-R' pattern in either of leads V1,V2 with R' amplitude ≤ R.

7-6 Incomplete left bundle branch block. (Do not code in the presence of any codable Q- or QS wave.) QRS duration ≥ 0.10 and < 0.12 sec in the majority of beats of each of leads I,aVL, and V5 or V6.

7-7 Left anterior hemiblock (LAH). QRS duration < 0.12 sec in the majority of beats in leads I,II,III,aVL,aVF plus Q wave amplitude ≥ 0.25 mm and < 0.03 sec duration in lead I, pluse left axis deviation of -45 or more negative. (In presence of 7-2, code 7-8 if axis is < -45and the Q-wave in lead I meets the above criteria.

7-8 Combination of 7-7 and 7-2.

Arrhythmias

8-1-1 Presence of frequent atrial or junctional premature beats (10% or more of recorded complexes).

8-1-2 Presence of frequent ventricular premature beats (10% or more of recorded complexes).

8-1-3 Presence of both atrial and/or junctional premature beats and ventricular premature beats (so that the individual frequencies are < 10% of complexes).

8-1-4 Wandering atrial pacemaker.

8-1-5 Presence of 8-1-2 and 8-1-4.

8-2-1 Ventricular fibrillation or ventricular asystole.

8-2-2 Persistent ventricular (indoventricular) rhythm.

8-2-3 Intermittent ventricular tachycardia. Three or more consecutive ventricular premature beats occuring at rate ≥ 100. This includes more persistent ventricular tachycardia.

8-2-4 Ventricular parasystole (should not be coded in presence of 8-3-1).

8-3-1 Atrial fibrillation (persistent).

8-3-2 Atrial flutter (persistent).

8-3-3 Intermittent atrial fibrillation (code #3 or more clear-cut, consecutivesinus beats are present in any lead).

8-3-4 Intermittent atrial flutter (code #3 or more clear-cut, consecutive sinus beats are present in any lead).

8-4-1 Supraventricular rhythm persistent. QRS duration < 0.12 sec; and absent P-waves or presence of abnormal P-waves (inverted or flat in AVF); and regular rhythm.

8-4-2 Supraventricular tachycardia intermittent. Three consecutive atrial or junctional premature beats occuring at a rate ≥ 100.

8-5-1 Sinoatrial arrest. Unexpected absence of P,QRS, and T, plus a R-Rinterval at a fixed mutiple of the normal interval ± 10%.

8-5-2 Sinoatrial block. Unexpected absence of P,QRS, and T, preceded by progressive shortening of P-P intervals. (R-R interval at a fixed multiple of the normal interval ± 10%.

8-6-1 A-V dissociation wi ventricular pacemaker (without capture). Requires: P-P and R-R occur at variable rates with ventricular rate as fast as or faster than the atrial rate, plus variable P-R intervals, plus no capture beats.

8-6-2 A-V dissociation with ventricular pacemaker (with capture).

8-6-3 A-V dissociation with atrial pacemaker (without capture).

8-6-4 A-V dissociation with atrial pacemaker (with capture).

8-7 Sinus tachycardia (over 100/ min).

8-8 Sinus bradycardia (under 50/min).8-9 Other arrhythmias. Heart rate may be recorded as a continuous variable.

ST Segment Elevation

Anterolateral Site(leads I,aVL,V6)

9-2 ST J segment elevation ≥ 1.0 mm in leads I,aVL,V6.

9-2-1 ST J segment elevation ≥ 1.5 mm in leads II,aVL,V6.

9-2-x ST J segment elevation ≥ x.0 mm in leads I,aVL,V6 -x must be 1.5 mm.

Posterior (inf) site leads II,III,aVF

9-2 ST J segment elevation ≥ 1.0 mm in leads II,III,aVF.

9-2-1 ST J segment elevation ≥ 1.5 mm in leads II,III,aVF.

9-2-x ST J segment elevation ≥ x.0 mm in leads II,III,aVF -x must be 1.5 mm.

Anterior site (leads V1,V2,V3,V4,V5)

9-2 ST J segment elevation ≥ 1.0 mm in lead V5 or ST segment elevation ≥ 2.0 mm in leads V1,V2,V3,V4.

9-2-1 ST J segment elevation ≥ 1.5 mm in lead V5 or ST segment elevation ≥ 2.5 mm in leads V1,V2,V3,V4.

9-2-x ST J segment elevation ≥ x.0 mm in leads V1,V2,V3,V4. x must be ≥ 2.5 mm.

Miscellaneous Items

9-1 Low QRS amplitude. QRS peak-to-peak amplitude < 5.0 mm in all beats in each of the leads I,II,III or < 1.0 mm in all beats in each of leads V1,V2,V3,V4,V5,V6. (Check calibration before coding.)

9-3 P-wave amplitude ≥ 2.5 mm in any of leads II,III,aVF, in a majority of beats.

9-4-1 QRS transition zone at V3 or to the right of V3 on the chest. (Do not code in the presence of 6-4-1, 7-1-1,7-2-1, or 7-4.)

9-4-2 QRS transition zone at V4 or to the left of V4 on the chest. (Do not code in the presence of 6-4-1, 7-1-1, 7-2-1, or 7-4.)

9-5 T-wave amplitude > 12 mm in any of leads I,II,III,aVL,aVF,V1,V2,V3,V4,V5,V6. (Do not code in the presence of 6-4-1,7-1-1,7-2-1, or 7-4.)

9-6-1 Invalid calibration.

9-6-2 Missing calibration.

9-6-4 Torso ECG.

9-6-5 Torso ECG. Invalid calibration pulse.
9-6-6 Torso ECG. Missing calibration pulse.
9-8-1 Technical problems which interfere with coding.
9-8-2 Technical problems which do not interfere with coding.
9-8-3 Photocopy. No technical problems which interfere with coding.
9-8-4 Photocopy. Technical problems which interfere with coding.

Incompatible Codes

The codes in the left column suppress codes in the right column.

Code	Suppresses this code (s)
All Q-QS codes	7-6
Q> 0.03 in lead I	7-7
3-1	1-3-2
3-2	1-2-8,7-3
6-1	All other codes except 8-2
6-4-1	All other codes
6-8	All other codes
7-1-1	1-2-3,1-2-7,1-2-8,1-3-2,1-3-6, all 2-,3-,4-, and 5- codes. 7-7,9-2,9-4,9-5.
7-2-1	1-2-8, all 2-,3-,4-, and 5- codes.9-2,9-4,9-5.
7-3	1-2-8
7-4	All 2-,3-,4-, and 5- codes.9-2,9-4,9-5.
8-1-2	8-2-4
8-1-4	8-1-1,9-3
8-2-1	All other codes
8-2-2	All other codes
8-2-3	8-1-2
8-3-1	8-1-1,8-1-2
8-3-2	6-2-2,8-1-1,8-1-2
8-3-3	8-1-1,8-1-2
8-3-4	6-2-2
8-4-1	6-5
8-4-1 + heart rate ≥ 140	All other codes except 7-4 or 6-2
Heart rate > 100	6-5
8-4-2	8-1-1
9-1	All 2-codes
8-3-2	6-2-2,8-1-1,8-1-2
8-3-3	8-1-1,8-1-2

QUALITY CONTROL

Health ABC Reproducibility Procedures

1. Perform SQL query to determine total number of ECGs coded
2. Run SQL query to generate random listing of ECGs (5%) to be included in the reproducibility dataset (R-dataset)
3. Import an electronic copy of inventory for the R-dataset to a temporary database.
4. Printout rest ECG analysis sheets for each of the ECGs in the R-dataset
5. Match up the analysis worksheet printout to the appropriate ECG, forward to data analysis in individually labeled data-folders.
6. R-dataset is analyzed as per standard operating procedures, i.e. 2 independent coders analyze the ECGs. A senior coder adjudicates discordant evaluations.
7. Independent data entry operators enter the analysis data twice in the temporary database.
8. A program is run to electronically match the 2 data entries, unmatched data is adjudicated by a supervisor.
9. A data consistency check is run on the final data set. Coding errors such as a heart rate < 50 without a corresponding bradycardia code are captured by the consistency check. Any records identified by the consistency check are corrected.
10. The final set is forwarded to the CoordinatingCcenter.